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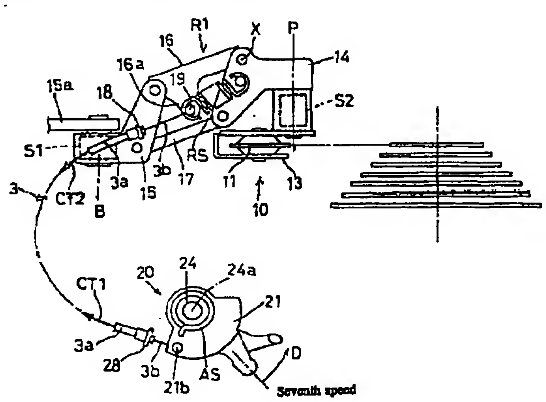
(54) **Bicycle shift control device with balanced spring tension**

(57) A shift control device comprises a movable member (21, 44) having a cable support (21b, 44b) for supporting the transmission cable (3), wherein the movable member moves as the shifting device actuates the transmission. An assist spring (AS) is provided for biasing the movable member in a direction opposite a direction of biasing of the movable member by the return spring (RS) of the transmission. The cable support supports the transmission cable such that the tension exerted by the assist spring on the transmission cable remains substantially constant regardless of a position of the movable member as the shifting device actuates the transmission. In a more specific embodiment, the cable support moves the transmission cable in a straight line, and the cable support may move the transmission cable without winding the transmission cable about the cable support.



[Figure 1]

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention is directed to bicycle shift control devices and, more particularly, to bicycle shift control devices which employ a return spring in the transmission (such as a derailleur) and an assist spring in the shift control lever.

[0002] A conventional shifting control device is provided with an assist spring for movably energizing the shifting control piece in the direction opposite to the direction in which the piece is energized by a return spring in the transmission (such as a derailleur). The assist spring assists the shifting operation by partially compensating for the cable tension created by the return spring. -

[0003] In such a shifting device, the operating force needed for down-shifting is the force obtained by adding the chain guide reaction force of the shifting control device and the frictional force of the control cable to the force obtained by subtracting the cable tension generated by the assist spring from the cable tension generated by the return spring. The operating force needed for up-shifting is obtained by adding the frictional force of the control cable to the cable tension generated by the assist spring. Down-shifting is accompanied by an increase in the spring force of the return spring and a reduction in the spring force of the assist spring, whereas up-shifting is accompanied by a reduction in the spring force of the return spring and an increase in the spring force of the assist spring.

[0004] Figures 13 and 14 show the relation between the tension **CT1** exerted by the assist spring on the control cable and the tension **CT2** exerted by the return spring on the control cable in some devices when, for example, the return spring of such a conventional shifting device energizes the derailleur in the direction of the top speed. As shown in Figure 13, the difference between the operating force required for shifting on the low side and the operating force required for shifting on the top side can be quite substantial. A known shifting device having the tension relation shown in Figure 14 has a smaller difference than does the shifting device having the tension relation shown in Figure 13. While this is some improvement, a difference still exists between the operating force required for shifting on the low side and the operating force required for shifting on the top side. Furthermore, it should be noted that the tension difference varies depending upon the position of the shifting device and the transmission. More specifically, the difference decreases until the tension curves intersect, and then it increases again. This difference can be distracting to cyclists engaged in high performance riding, since there is a risk that the cyclist will underestimate or overestimate the shifting force required to go from one gear to another. This can result in missed shifts or incorrect shifts.

[0005] It should also be noted that in each case the cable tension **CT2** generated by the return spring and the cable tension **CT1** generated by the assist spring differ for some or all of the positions lying between the low position and the top position. Thus, if the initial positional relationship between the shift control device and the transmission changes due to stretching of the transmission cable or for some other reason, then tension characteristics will change as well. This could cause the entire system to no longer conform to design specifications. Also, it could further confuse cyclists who engage in high performance riding, since then the tension characteristics of the shifting device depend on how the transmission was set or adjusted by the bicycle mechanic, the amount of wear in the transmission, etc..

[0006] Sometimes the derailleur is configured in such a way that the tension exerted by the return spring on the control cable is constant or virtually constant irrespective of the movement of the guide pulley. As shown in Figure 15, the combined operation of the derailleur and shift control device still brings about a comparatively large increase in the difference between the cable tension **CT1** exerted by the assist spring and the cable tension **CT2** exerted by the return spring on the low-speed side. While such devices reduce the difference between the operating force exerted during shifting to a lower speed on the low-speed side and the operating force exerted during shifting to a lower speed on the high-speed side in comparison with Figure 13, again a difference still exists.

SUMMARY OF THE INVENTION

[0007] The present invention is directed to a shift control device constructed with an assist spring such that the cable tension exerted on the transmission cable is substantially constant throughout substantially the entire operating range of the shift control device. This reduces the difference between the operating force required for shifting on the low side of the transmission and the operating force required for shifting on the top side of the transmission.

[0008] The present invention is also directed to a shift control device and transmission device wherein the tension on a transmission cable caused by an assist spring in the shift control device is balanced with the tension on the transmission cable caused by a return spring in the transmission. In other words, the difference in tension between the assist spring and the return spring remain substantially constant throughout substantially the entire operating range of the transmission. Thus, the cyclist can more readily estimate the amount of shifting force required to shift from one gear to another.

[0009] Furthermore, if both the shift control device and the transmission are constructed so that the cable tension exerted on the transmission cable by both the assist spring and the return spring is substantially constant throughout substantially the entire operating range

of the shift control device and transmission, then the same operating force is required to shift from one gear to any other gear. This makes it very easy for the cyclist to estimate the force required to switch from one gear to another. Furthermore, even if the initial positional relationship between the shift control device and the transmission changes due to stretching of the transmission cable or for some other reason, the overall tension characteristics will not change.

[0010] In one embodiment of the present invention, a shift control device comprises a movable member having a cable support for supporting the transmission cable, wherein the movable member moves as the shifting device actuates the transmission. An assist spring is provided for biasing the movable member in a direction opposite a direction of biasing of the movable member by the return spring of the transmission. The cable support supports the transmission cable such that tension exerted by the assist spring on the transmission cable remains substantially constant regardless of a position of the movable member as the shifting device actuates the transmission. In a more specific embodiment, the cable support moves the transmission cable in a straight line, and the cable support may move the transmission cable without winding the transmission cable about the cable support. In a very specific embodiment, the transmission cable includes an outer cable surrounding an inner cable, and the shift control device includes an outer holder for supporting the outer cable at the shift control device, wherein the cable support supports the inner cable so that the inner cable extends in a straight line from the outer holder to a location where the inner cable is connected to the cable support. A transmission, such as a derailleur, may be constructed in a similar manner. When such a transmission and shift control device are operated together, then the tension exerted on the cable by each device is substantially constant throughout substantially the entire operating range of the system.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

Figure 1 is a diagram of a particular embodiment of the present invention wherein a rear derailleur is disposed at a small freewheel gear;

Figure 2 is a diagram of a particular embodiment of the present invention wherein a rear derailleur is disposed at a large freewheel gear;

Figure 3 is a side view of a particular embodiment of a rear derailleur according to the present invention;

Figure 4 is a top view of a particular embodiment of a shift control device according to the present invention;

Figure 5 is a top cross-sectional view of the shift control device shown in Figure 4;

Figur 6 is a side cross-sectional view of the shift control device shown in Figure 4;

Figure 7 is a rear view of the shift control device shown in Figure 4;

Figure 8 is a geometrical diagram illustrating cable tension in a rear derailleur and shift control device according to the present invention;

Figure 9 is a diagram of a particular embodiment of an assist spring employed in a shift control device according to the present invention;

Figure 10 is a graph illustrating cable tension in a particular embodiment of the present invention;

Figure 11 is a diagram of an alternative embodiment of the present invention;

Figure 12 is a geometrical diagram of cable tension in a particular embodiment of the present invention;

Figure 13 is a graph illustrating cable tension in a prior art shifting mechanism;

Figure 14 is a graph illustrating cable tension in another prior art shifting mechanism;

Figure 15 is a graph illustrating cable tension in another prior art shifting mechanism;

Figure 16 is a graph illustrating cable tension in another embodiment of the present invention; and

Figure 17 is a graph illustrating cable tension in another embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0012] As shown in Figure 4, a bicycle shifting control device **20** is formed by attaching a single shifting lever **21** to a lever bracket **22** shaped in such a way that a brake lever **5** can be attached close to the grip of a handlebar **2**. The bicycle shifting control device **20** is connected by a control cable **3** consisting of an outer cable **3a** and an inner cable **3b** to a bicycle rear derailleur **10** equipped with a guide pulley **11**, a return spring **RS**, and the like, as shown in Figure 1, and a chain **4** is moved between the seven rear gears for driving the rear wheel of a bicycle by operating the rear derailleur **10** with the aid of the shifting lever **21** through the intermediary of the control cable **3**. The structure will now be described in detail.

[0013] Specifically, as shown in Figures 4, 5, and 6, the aforementioned lever bracket **22** is attached to the handlebar **2** by setting a band portion **22a**, provided on the side opposite to the side on which the brake lever **5** is positioned, on the handlebar **2** and fastening said bracket with the aid of an attachment screw **22b**. Attached to this lever bracket **22** are a spindle member **24** configured in such a way that it can be fastened and fixed with an attachment screw **23**, and a pawl holder **25** configured in such a way that it can be fastened and fixed to the lever bracket **22** with the aid of the spindle member **24**. The aforementioned shifting lever **21** is supported on the aforementioned spindle member **24** while being allowed to rotate about the axis **24a** of the spindle member **24**, and a cover **26** that houses the

base portion **21a** of the shifting lever **21** and the like is fixed to the end portion of the spindle member **24** with the aid of an attachment screw **27**, forming a structure in which the end portion provides a spline engagement without the possibility of rotation. The base portion **21a** of the shifting lever **21** houses an assist spring (torsional coil spring) **AS**. The aforementioned cover **26** is equipped with an outer holder **28** for supporting the outer cable **3a** of the control cable **3**, and with a cable support **21b** configured in such a way that the inner cable **3b** of the control cable **3** is connected to the aforementioned shifting lever **21** by catching and holding a cable nipple **3c**. The aforementioned shifting control device **20** is thus configured.

[0014] That is, the shifting lever **21** is attached to the handlebar **2** with the aid of the spindle member **24** and the lever bracket **22** serving as attachment members, while being allowed to perform a reciprocating swinging motion about the axis **24a**, and is operated by either of two finger control tabs **21A** and **21B** that are provided to the portions projecting beyond the cover **26** of the shifting lever **21** in such a way that these tabs are positioned below the handlebar **2** separately from each other in the direction of travel of the shifting lever **21**. Specifically, when the shifting lever **21** is to be actuated in the swing direction **D** shown in Figure 5, the thumb is brought into contact with the finger control tab **21A** and control may be performed over the entire stroke using the finger control tab **21A** alone, and when the shifting lever **21** is to be actuated in the swing direction **U** shown in Figure 5, the forefinger is brought into contact with the finger control tab **21B** and control may be performed over the entire stroke using the finger control tab **21B** alone.

[0015] Seven positioning detents **21e** provided to the positioning portion **21c** of the shifting lever **21**, and a positioning pawl **29** made of resin and attached to the aforementioned pawl holder **25** constitute a positioning mechanism for positioning the shifting lever **21** in seven predetermined operating positions. Because a positioning ball or the like can also be adopted instead of the positioning pawl **29**, these will all be referred to collectively as "the positioning pawl **29**." Specifically, when the shifting lever **21** is swung, the resulting operating force will cause the active portion **29a** of the positioning pawl **29** to engage a positioning detent **21e** or disengage from it, and when the active portion **29a** of the positioning pawl **29** enters a positioning detent **21e**, the engagement of the active portion **29a** brings the shifting lever **21** in a predetermined operating position. That is, the shifting lever **21** moves between the position of the lowest (first) speed, in which, of the seven positioning detents **21e**, the positioning detent **21e** closest to one edge registers with the active portion **29a** of the positioning pawl **29**, and the position of the highest (seventh) speed, in which, of the seven positioning detents **21e**, the positioning detent **21e** closest to the other edge registers with the active portion **29a** of the positioning pawl **29**.

[0016] The cable support **21b** is formed in such a way that the inner cable **3b** is pulled out from the outer cable **3a** as the shifting lever **21** is down-shifted, the inner cable **3b** is let out toward th derailleur as the shifting lever **21** is up-shifted, and the inner cable **3b** that has been pulled out of the outer cable **3a** remains stretched in a straight line without being wound. The assist spring **AS** rests against the lever bracket **22** as a result of the fact that one end of the spring is fixed in the seat **25a** for attaching the pawl holder **25** to the lever bracket **22**, and the other end rests against the base portion **21a** of the shifting lever **21** and is used to energize the shifting lever **21** into the aforementioned first-speed position. Specifically, energizing is performed in a direction opposite to that in which the shifting lever **21** is energized by the return spring **RS** of the derailleur **10** through the intermediary of the control cable **3**.

[0017] As shown in Figure 8, when the shifting lever **21** moves through the operating range between the first-speed position and the seventh-speed position, the cable support **21b** that serves as the support point of the inner cable **3b** moves along a circular-arc trajectory **T** whose center is the swing axis **24a** of the shifting lever **21**. Assuming that an assist force **AF** for swinging the shifting lever **21** is generated for the assist spring **AS** along this trajectory **T**, cable tension **CT1** is exerted on the inner cable **3b** between the cable support **21b** and the outer holder **28** due to this assist force **AF**. The tension value ratio of the cable tension **CT1** to the assist force **AF** varies with the inclination angle **A** formed by the inner cable **3b** with a line **L** passing through the swing axis **24a** and the cable support **21b**. As a result, changing the aforementioned inclination angle **A** in a suitable manner prevents the cable tension **CT1** from undergoing any changes or makes these changes smaller than those of the assist force **AF** even when the cable support **21b** moves, and the assist force **AF** changes due to the torsional changes of the assist spring **AS**.

[0018] The aforementioned inclination angle **A** is determined by setting the positional relationship for the cable support **21b** of the shifting lever **21** and the outer holder **28** of the cover **26**. Selecting a suitable positional relationship for the cable support **21b** and the outer holder **28** will therefore yield a virtually constant cable tension **CT1**, exerted on the inner cable **3b** by the assist spring **AS**, when the shifting lever **21** is brought to any of the first-through seventh-speed positions or to any speed position between the first- and seventh-speed positions (between the first- and second-speed positions, between the fourth- and fifth-speed positions, etc.), that is, to any operating position within the entire operating range. Based on this, the torsional coil spring shown in Figure 9 is adopted as the assist spring **AS**, the cable support **21b** and the outer holder **28** are arranged in such a way that the positional relationship shown in Figure 8 is obtained, and the virtually constant cable tensions **CT1-1** and **CT1-2** shown in Figure 10 are

generated.

[0019] Specifically, the cable support **21b** and the outer holder **28** are arranged in such a way that moving the shifting lever **21** to the first-speed position brings the axis of the inner cable **3b** extending between the outer holder **28** and the cable support **21b** to a distance **D1** of about 25.9 mm from the swing axis **24a** of the shifting lever **21**, and moving the shifting lever **21** to the seventh-speed position brings the axis of the inner cable **3b** extending between the outer holder **28** and the cable support **21b** to a distance **D7** of about 29 mm from the aforementioned swing axis **24a**. The cable tensions **CT1-1** and **CT1-2** shown in Figure 10 were measured when the tension exerted on the inner cable **3b** by the outer holder **28** was measured for a case in which the shifting lever **21** was operated while the positioning pawl **29** was removed and prevented from acting on the shifting lever **21**. Specifically, the cable tension **CT1-1** has a magnitude of 3.35 to 3.4 kgf at the cable tension generated when the shifting lever **21** is up-shifted from the first- to the seventh-speed position. Friction and the like create a certain difference between the cable tension **CT1-1** generated when the shifting lever **21** is up-shifted and the cable tension **CT1-2** generated during downshifting. That is, the assist spring **AS** exerts a virtually constant cable tension **CT1** of 2.68 to 3.4 kgf on the inner cable **3b** when the shifting lever **21** is placed in any operating position within the entire operating range.

[0020] When a derailleur is shifted in the operating direction against the action of the return spring, extra operating force is provided by the assist spring, and shifting can be performed while the operating force to be applied by the rider is reduced by the amount of assistance provided by the assist spring. In the process, the cable support holds the control cable in such a way that the cable tension exerted by the assist spring remains constant or virtually constant in any operating position of the shifting control piece, so when a derailleur in which the return spring exerts a varying cable tension is actuated, the cable tension **CT1** exerted by the assist spring and the cable tension **CT2** exerted by the return spring are in the tension relation shown in Figure 16, making it possible to perform shifting while the difference between the human-assisted operating force required for the lower-speed side and the human-assisted force required for the higher-speed side is reduced in comparison with the conventional example shown in Figure 13. In addition, when a derailleur in which the return spring exerts constant or virtually constant cable tension is operated, the cable tension **CT1** exerted by the assist spring and the cable tension **CT2** exerted by the return spring are in the tension relation shown in Figure 10, making it possible to perform shifting while the difference between the human-assisted operating force required for the lower-speed side and the human-assisted force required for the higher-speed side is reduced in comparison with the conventional example shown in Figure 13.

[0021] The rear derailleur **10** is configured as shown in Figures 1 and 3. Specifically, the following two components are connected together with the aid of a pair of left and right swing links **16** and **17**: a support **14** to which a guide pulley **11** and a tension pulley **12** are attached by means of a chain guide **13**, and a bracket **15** configured to allow bolt connection to the rear wheel fork **1** by means of a connecting plate **15a**. The support **14**, the swing links **16** and **17**, and the bracket **15** are configured in such a way that they form a parallel four-link mechanism **R1**. A return spring **RS** serving as a tension coil spring is attached between the support **14** and a control arm **16a** projecting from the right swing link **16** toward the left swing link **17** (the two links form a pair of left and right swing links **16** and **17**); a first tension spring **S1** (torsional coil spring) is housed in that part of the connecting plate **15a** of the bracket **15** which is connected while allowed to rotate about an axis **B**; and a second tension spring **S2** (torsional coil spring) is housed in that part of the chain guide **13** of the support **14** which is connected while allowed to rotate about an axis **P**. The bracket **15** is provided with an outer holder **18** for supporting the outer cable **3a** of the control cable **3**, and the aforementioned control arm **16a** is provided with a cable support configured in such a way that the inner cable **3b** of the control cable **3** can be fastened and connected with the aid of a cable fixing screw **19**.

[0022] That is, the guide pulley **11** is attached by means of the parallel four-link mechanism **R1** to a derailleur attachment **1a** projecting from the fork end portion of the rear wheel fork **1**, and is allowed to move in a reciprocating fashion across the frame. This allows the guide pulley **11** to move in a reciprocating fashion across the frame between the first-speed position (the lowest speed), where the chain **4** is engaged by the lowest of the seven gears, that is, by one having the largest diameter and lying on the side closest to the frame, as shown in Figure 2, and the seventh-speed position (the highest speed), where the chain **4** is engaged by the top gear of the seven gears, that is, by one having the smallest diameter and lying on the side farthest from the frame, as shown in Figure 1.

[0023] A tensile force exerted by the inner cable **3a** moves the chain over the seven rear gears from the small-diameter side to the large-diameter side, changing chain engagement from higher speeds to lower speeds. An elastic recovery force exerted by the return spring **RS** moves the chain over the seven rear gears from the large-diameter side to the small-diameter side, changing chain engagement from lower speeds to higher speeds. One end of the first tension spring **S1** rests against the connecting plate **15a**, and the other end against the bracket **15**. The first tension spring **S1** energizes the bracket **15** in the swing direction **BF** about the axis **B** with respect to the rear wheel fork **1**, and tension is thus exerted on the chain **4** through the intermediary of the guide pulley **11** and the tension pulley **12**. One end of the second tension spring **S2** rests against

the support **14**, and the other end against the chain guide **13**. The second tension spring **S2** energizes the chain guide **13** in the swing direction **PF** about the axis **P** with respect to the support **14**, and tension is thus exerted on the chain **4** through the intermediary of the guide pulley **11** and the tension pulley **12**.

[0024] As shown in Figure 8, when the guide pulley **11** of the rear derailleur **10** moves from the first-speed position toward the seventh-speed position, the cable fixing screw **19** that serves as the connection point of the inner cable **3b** moves along a circular-arc trajectory **T** whose center is a connecting pin axis **X** serving as the connection center between the right swing link **16** and the bracket **15**. If it is assumed that a return force **RF** for swinging the right swing link **16** is generated for the return spring **RS** along this trajectory **T**, then cable tension **CT2** will be exerted on the inner cable **3b** between the connection point **19** and the outer holder **18** due to this return force **RF**. The tension value ratio of this cable tension **CT2** to the return force **RF** varies with the inclination angle **A** formed by the inner cable **3b** with a line **L** passing through the connecting pin axis **X** and the connection point **19**. As a result, changing the aforementioned inclination angle **A** in a suitable manner prevents the cable tension **CT2** from undergoing any changes or makes these changes smaller than those of the return force **RF** even when the connection point **19** moves, and the return force **RF** is changed due to changes in the length of the return spring **RS**.

[0025] The aforementioned inclination angle **A** is determined by setting the positional relationship for the cable connection point **19** of the right swing link **16** and the outer holder **18** of the bracket **15**. Selecting a suitable positional relationship for the cable connection point **19** and the outer holder **18** will therefore yield a constant or virtually constant tension **CT2**, exerted on the inner cable **3b** by the return spring **RS**, when the guide pulley **11** is brought to any of the first- through seventh-speed positions or to any speed position between the first- and seventh-speed positions (between the first- and second-speed positions, between the fourth- and fifth-speed positions, etc.), that is, to any position within the entire operating range, in a slate in which the chain **4** is not wound around the guide pulley **11** or the tension pulley **12** and in which there is no guide reaction from chain **4** on the guide pulley **11**. Arranging the outer holder **18** and the cable connection point **19** of the right swing link **16** on the basis of the above considerations allows the return spring **RS** to exert a cable tension **CT2** of 2.68 to 3.4 kgf on the inner cable **3b** irrespective of the position of the guide pulley **11** in a state in which the chain **4** engages neither the guide pulley **11** nor the tension pulley **12** and there is no guide reaction from chain **4** on the guide pulley **11**.

[0026] That is, when the shifting lever **21** is operated while the positioning pawl **29** does not act on the shifting lever **21** in a state in which the rear derailleur **10** and the shifting control device **20** are merely connected together by the control cable **3** but remain unattached to the frame, or in a state in which the components are attached to the frame but the chain **4** engages neither the guide pulley **11** nor the tension pulley **12** and there is no guide reaction from the chain **4** on the guide pulley **11**, balance exists between the cable tension **CT2** exerted by the return spring **RS** on the inner cable **3b** and the cable tension **CT1** exerted by the assist spring **AS** on the inner cable **3b**, even in cases in which the shifting lever **21** is brought to any of the first- through seventh-speed positions or to any speed position between the first- and seventh-speed positions (between the first- and second-speed positions, between the fourth-and fifth-speed positions, etc.), that is, to any position within the entire operating range.

[0027] In short, during down-shifting the shifting lever **21** is actuated in the swing direction **D** shown in Figures 1 and 5. In this case the shifting lever **21** pulls the inner cable **3b**, and the inner cable **3b** moves the guide pulley **11** together with the tension pulley **12** toward the frame while elastically deforming the return spring **RS**. As a result, the guide pulley **11** guides the chain **4** from the small-diameter side to the large-diameter side of the rear gears, and to switch the shifting stage from higher speeds to lower speeds. When the shifting stage is switched at this time to any speed between the first and seventh speeds, balance is preserved between the tension **CT2** exerted by the return spring **RS** on the inner cable **3b** and the tension **CT1** exerted by the assist spring **AS**, and the assist spring **AS** provides the extra operating force necessary to elastically deform the return spring **RS**. As a result, the shifting lever **21** is actuated by means of a human-initiated operating force against the chain guide resistance acting on the guide pulley **11**, against the friction between the inner cable **3b** and the outer cable **3a** of the control cable **3**, and against the operating resistance of the positioning pawl **29**.

[0028] During up-shifting the shifting lever **21** is actuated in the swing direction **U** shown in Figures 2 and 5. In this case the shifting lever **21** lets out the inner cable **3b**, and the letting-out of the cable allows the return spring **RS** to undergo elastic recovery and to move the guide pulley **11** together with the tension pulley **12** away from the frame against the chain guide resistance acting on the two pulleys **11** and **12**. As a result, the guide pulley **11** changes the engagement of the chain **4** from the large-diameter side of the rear gears to the small-diameter side, and the shifting stage switches from lower speeds to higher speeds. When the shifting stage is switched at this time to any speed between the first and seventh speeds, balance is preserved between the tension **CT2** exerted by the return spring **RS** on the inner cable **3b** and the tension **CT1** exerted by the assist spring **AS**, and the return spring **RS** provides the extra operating force necessary to elastically deform the assist spring **AS**. As a result, the shifting lever **21** is actuated by means of a human-initiated operating force

the assist spring **AS**.

[0034] With the link-type shifting control device **40**, the cable fixing screw **19** serving as the connection point of the inner cable **3b** moves along a circular-arc trajectory **T** as shown in Figure 12 whose center is a connecting pin axis **X** serving as the connection center between the swing link **44** and the attachment member **41**. If it is assumed that an assist force **AF** for swinging the swing link **44** is generated for the assist spring **AS** along this trajectory **T**, then cable tension **CT1** will be exerted on the inner cable **3b** between the cable connection point **19** and the outer holder **18** due to this assist force **AF**. The tension value ratio of this cable tension **CT1** to the assist force **AF** varies with the inclination angle **A** formed by the inner cable **3b** with a line **L** passing through the cable connection point **19** and the connecting pin axis **X**. As a result, changing the aforementioned inclination angle **A** in a suitable manner prevents the cable tension **CT1** from undergoing any changes or makes these changes smaller than those of the assist force **AF** even when the cable connection point **19** moves and the assist force **AF** changes due to changes in the length of the assist spring **AS**. The aforementioned inclination angle **A** is determined by setting the positional relationship for the cable connection point **19** of the swing link **44** and the outer holder **18** of the shifting lever **42**. Selecting a suitable positional relationship for the cable support component **44b** and the outer holder **18** will therefore yield a constant or virtually constant cable tension **CT1** exerted by the assist spring **AS**, irrespective of the changes in the operating position of the shifting lever **42**. The specifications of the parallel four-link mechanism **R2** for this shifting control device can be the same as those of the parallel four-link mechanism **R1** for the derailleur **10**, and the same kind of balance can be achieved between the tension **CT1** exerted on the inner cable **3b** by the assist spring **AS** of the shifting control device **40** and the tension **CT2** exerted on the inner cable **3b** by the return spring **RS** of the derailleur **10**.

[0035] While the above is a description of various embodiments of the present invention, further modifications may be employed without departing from the spirit and scope of the present invention. For example, the present invention was described as applying to a shifting control device for a rear derailleur, but it can also be applied to a shifting control device for a front derailleur. In that case, the guide pulley **11** and a guide pulley for changing the chain engagement of a front derailleur will therefore be collectively referred to as "chain guide members **11**," and the aforementioned parallel four-link mechanisms **R1** will be collectively referred to as "coupling mechanisms **R1** for attaching the chain guide members **11** to the bicycle frame."

[0036] The shifting control device attachable to the handlebar can have a structure in which the device is supported on the lever bracket **22** and is attached to the handlebar **2** together with the brake lever **5**. It is also possible to have a structure in which a dedicated attachment member separate from the lever bracket **22** is provided, and the device is independently attached to the handlebar **2** separately from the brake lever **5**. The present invention is also applicable to a case in which the shifting control device is formed by a rotary controller rotatably set on a handlebar instead of the aforementioned shifting levers **21** and **42**. Such a controller forms a handlebar grip and is designed for operating the derailleurs through the intermediary of a control cable. These shifting levers and rotary controllers will therefore be collectively referred to as "shifting control pieces **21** and **42**," and the lever bracket **22** will be referred to as "the base member **22**."

[0037] The present invention is applicable to a case in which the shifting control device is designed for controlling a derailleur configured in such a way that the return spring actuates the chain guide member in the direction of higher speeds, as well as to a case in which the shifting control device is designed for controlling a derailleur configures in such a way that the return spring actuates the chain guide member in the direction of lower speeds. In such a case, the assist spring energizes the shifting control pieces in the direction of higher speeds.

[0038] The shifting control device pertaining to the present invention can be used to operate a derailleur in which the cable tension exerted by the return spring is kept constant or virtually constant, and balance is maintained with respect to the cable tension generated by the assist spring. The shifting control device pertaining to the present invention can also be used to operate a derailleur in which the cable tension exerted by the return spring is constant or virtually constant, but there is no balance with respect to the cable tension generated by the assist spring, or to operate a derailleur in which the cable tension generated by the return spring varies with shifting. Alternatively, it can also be applied to a case in which, as shown in Figure 17, the cable tension **CT1** and the cable tension **CT2** remain balanced while their values change as the two springs are deformed.

[0039] Thus, the scope of the invention should not be limited by the specific structures disclosed. Instead, the true scope of the invention should be determined by the following claims. Of course, although labeling symbols are used in the claims in order to facilitate reference to the figures, the present invention is not intended to be limited to the constructions in the appended figures by such labeling.

Claims

1. A bicycle shifting device comprising:

    a bicycle derailleur (10) including:
    A derailleur base member (15) for coupling the derailleur (10) to a bicycle frame;
    a guide pulley (11) coupled to the derailleur

the assist spring **AS**.

[0034] With the link-type shifting control device **40**, the cable fixing screw **19** serving as the connection point of the inner cable **3b** moves along a circular-arc trajectory **T** as shown in Figure 12 whose center is a connecting pin axis **X** serving as the connection center between the swing link **44** and the attachment member **41**. If it is assumed that an assist force **AF** for swinging the swing link **44** is generated for the assist spring **AS** along this trajectory **T**, then cable tension **CT1** will be exerted on the inner cable **3b** between the cable connection point **19** and the outer holder **18** due to this assist force **AF**. The tension value ratio of this cable tension **CT1** to the assist force **AF** varies with the inclination angle **A** formed by the inner cable **3b** with a line **L** passing through the cable connection point **19** and the connecting pin axis **X**. As a result, changing the aforementioned inclination angle **A** in a suitable manner prevents the cable tension **CT1** from undergoing any changes or makes these changes smaller than those of the assist force **AF** even when the cable connection point **19** moves and the assist force **AF** changes due to changes in the length of the assist spring **AS**. The aforementioned inclination angle **A** is determined by setting the positional relationship for the cable connection point **19** of the swing link **44** and the outer holder **18** of the shifting lever **42**. Selecting a suitable positional relationship for the cable support component **44b** and the outer holder **18** will therefore yield a constant or virtually constant cable tension **CT1** exerted by the assist spring **AS**, irrespective of the changes in the operating position of the shifting lever **42**. The specifications of the parallel four-link mechanism **R2** for this shifting control device can be the same as those of the parallel four-link mechanism **R1** for the derailleur **10**, and the same kind of balance can be achieved between the tension **CT1** exerted on the inner cable **3b** by the assist spring **AS** of the shifting control device **40** and the tension **CT2** exerted on the inner cable **3b** by the return spring **RS** of the derailleur **10**.

[0035] While the above is a description of various embodiments of the present invention, further modifications may be employed without departing from the spirit and scope of the present invention. For example, the present invention was described as applying to a shifting control device for a rear derailleur, but it can also be applied to a shifting control device for a front derailleur. In that case, the guide pulley **11** and a guide pulley for changing the chain engagement of a front derailleur will therefore be collectively referred to as "chain guide members **11**," and the aforementioned parallel four-link mechanisms **R1** will be collectively referred to as "coupling mechanisms **R1** for attaching the chain guide members **11** to the bicycle frame."

[0036] The shifting control device attachable to the handlebar can have a structure in which the device is supported on the lever bracket **22** and is attached to the handlebar **2** together with the brake lever **5**. It is also possible to have a structure in which a dedicated attachment member separate from the lever bracket **22** is provided, and the device is independently attached to the handlebar **2** separately from the brake lever **5**. The present invention is also applicable to a case in which the shifting control device is formed by a rotary controller rotatably set on a handlebar instead of the aforementioned shifting levers **21** and **42**. Such a controller forms a handlebar grip and is designed for operating the derailleurs through the intermediary of a control cable. These shifting levers and rotary controllers will therefore be collectively referred to as "shifting control pieces **21** and **42**," and the lever bracket **22** will be referred to as "the base member **22**."

[0037] The present invention is applicable to a case in which the shifting control device is designed for controlling a derailleur configured in such a way that the return spring actuates the chain guide member in the direction of higher speeds, as well as to a case in which the shifting control device is designed for controlling a derailleur configures in such a way that the return spring actuates the chain guide member in the direction of lower speeds. In such a case, the assist spring energizes the shifting control pieces in the direction of higher speeds.

[0038] The shifting control device pertaining to the present invention can be used to operate a derailleur in which the cable tension exerted by the return spring is kept constant or virtually constant, and balance is maintained with respect to the cable tension generated by the assist spring. The shifting control device pertaining to the present invention can also be used to operate a derailleur in which the cable tension exerted by the return spring is constant or virtually constant, but there is no balance with respect to the cable tension generated by the assist spring, or to operate a derailleur in which the cable tension generated by the return spring varies with shifting. Alternatively, it can also be applied to a case in which, as shown in Figure 17, the cable tension **CT1** and the cable tension **CT2** remain balanced while their values change as the two springs are deformed.

[0039] Thus, the scope of the invention should not be limited by the specific structures disclosed. Instead, the true scope of the invention should be determined by the following claims. Of course, although labeling symbols are used in the claims in order to facilitate reference to the figures, the present invention is not intended to be limited to the constructions in the appended figures by such labeling.

Claims

1. A bicycle shifting device comprising:

   a bicycle derailleur (10) including:
   A derailleur base member (15) for coupling the derailleur (10) to a bicycle frame;
   a guide pulley (11) coupled to the derailleur

base member (15) for movement in a reciprocating manner;
a return spring (RS) for biasing the guide pulley (11) in a return direction;
a movable derailleur member (16) having a derailleur control cable support (19) for supporting a control cable (3), wherein the movable derailleur member (16) moves as a guide pulley (11) reciprocates;
wherein the derailleur control cable support (19) supports the control cable (3) so that the return spring (RS) exerts a first tension on the control cable (3) as the guide pulley (11) reciprocates;
a shift control device (20, 40) for actuating the derailleur (10) through the control cable (3) including;
a movable shift control member (21, 44) having a shift control cable support (21b, 44b) for supporting the control cable (3), wherein the movable shift control member (21, 44) moves as the shifting device actuates the derailleur (10);
an assist spring (AS) for biasing the movable shift control member (21, 44) in a direction opposite a direction of biasing of the movable shift control member (21, 44) by the return spring (RS); and
wherein the shift control cable support (21b, 44b) supports the control cable (3) so that the assist spring (AS) exerts a second tension on the control cable (3) as the shifting device actuates the derailleur (10);
wherein a difference between the first tension and the second tension remains substantially constant across substantially the entire opening range of the shift control device.

2. The device according to Claim 1 wherein the first tension and the second tension remain substantially constant across substantially the entire operating range of the shift control device (20, 40).

3. The device according to Claim 1 wherein the difference between the first tension and the second tension remains substantially constant across substantially the entire operating range of the shift control device in a state where no guide pulley reaction acts on the guide pulley (11).

4. The device according to Claim 1 wherein the movable shift control member (21) is rotatably supported by a shift control base member (22), and wherein the assist spring (AS) comprises a torsional coil spring connected between the shift control base member (22) and the movable shift control member (21).

5. The device according to Claim 4 wherein the movable shift control member (21) comprises a shifting lever having first and second finger control tabs (21a, 21b) in separate positions in the direction of movement of the movable shift control member (21), and further comprising:

a positioning unit (21e, 25, 29) for positioning the movable shift control member (21) in selected operating positions.

6. The device according to Claim 5 wherein the shift control base member (22) comprises a lever bracket for connecting a brake lever (5) to the handlebar (2).

7. The device according to Claim 1 wherein the shift control cable support (21b, 44b) move the control cable (3) in a straight line.

8. The device according to Claim 7 wherein the shift control cable support (21b, 44b) moves the control cable (3) without winding the control cable (3) about the shift control cable support (21b, 44b).

9. The device according to Claim 1 wherein the control cable (3) includes an outer cable (3a) surrounding an inner cable (3b), and further comprising a shift control outer holder (28) for supporting the outer cable (3a) at the shifting device, wherein the shift control cable support (21b, 44b) supports the inner cable (3b) so that the inner cable extends in a straight line from the shift control outer holder (28) to a location where the inner cable (3b) is connected to the shift control cable support (21b, 44b).

10. The device according to Claim 1 wherein the shift control device (20, 40) further comprises:

a shift control base member (41);
a manually operated shift control lever (42a);
a first shift control connecting link (43) having a first end connected to the shift control base member (41) and a second end connected to the shift control lever (42a);
wherein the movable shift control member (44) comprises a second shift control connecting link having a first end connected to the shift control base member (41) and a second end connected to the shift control lever (42a); and
wherein the shift control cable support (44b) comprises a projection on the movable shift control member.

11. The device according to Claim 10 wherein the assist spring (AS) comprises a coil spring having a first end connected to the projection and a second end connected to the shift control base member (41).

12. The device according to Claim 1 wherein the derailleur further comprises:

    a first derailleur connecting link (17) having a first end connected to the base member (15) and a second end connected to the guide pulley (11);
    wherein the movable derailleur member (16) comprises a second derailleur connecting link having a first end connected to the base member (15) and a second end connected to the guide pulley (11); and
    wherein the derailleur control cable support (19) comprises a projection on the movable derailleur member (16).

13. The device according to Claim 12 wherein the derailleur control cable support (19) moves the control cable (3) in a straight line.

14. The device according to Claim 13 wherein the derailleur control cable support (19) moves the control cable without winding the control cable (3) about the derailleur control cable support (19).

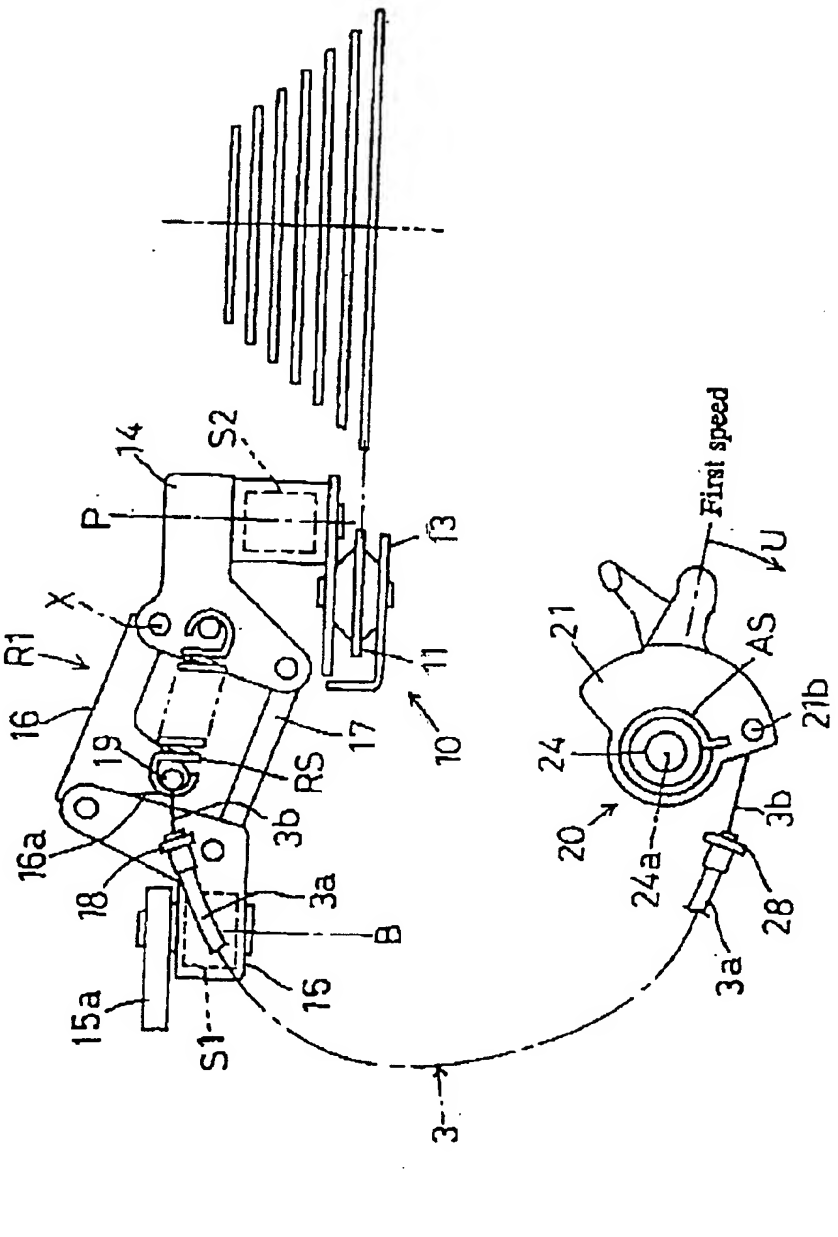
15. The device according to Claim 12 wherein the control cable (3) includes an outer cable (3a) surrounding an inner cable (3b), and further comprising a derailleur outer holder (18) for supporting the outer cable (3a) at the derailleur, wherein the derailleur control cable support (19) supports the inner cable (3b) so that the inner cable (3b) extends in a straight line from the derailleur outer holder (18) to a location where the inner cable (3b) is connected to the derailleur control cable support (19).

16. A bicycle shifting device comprising:

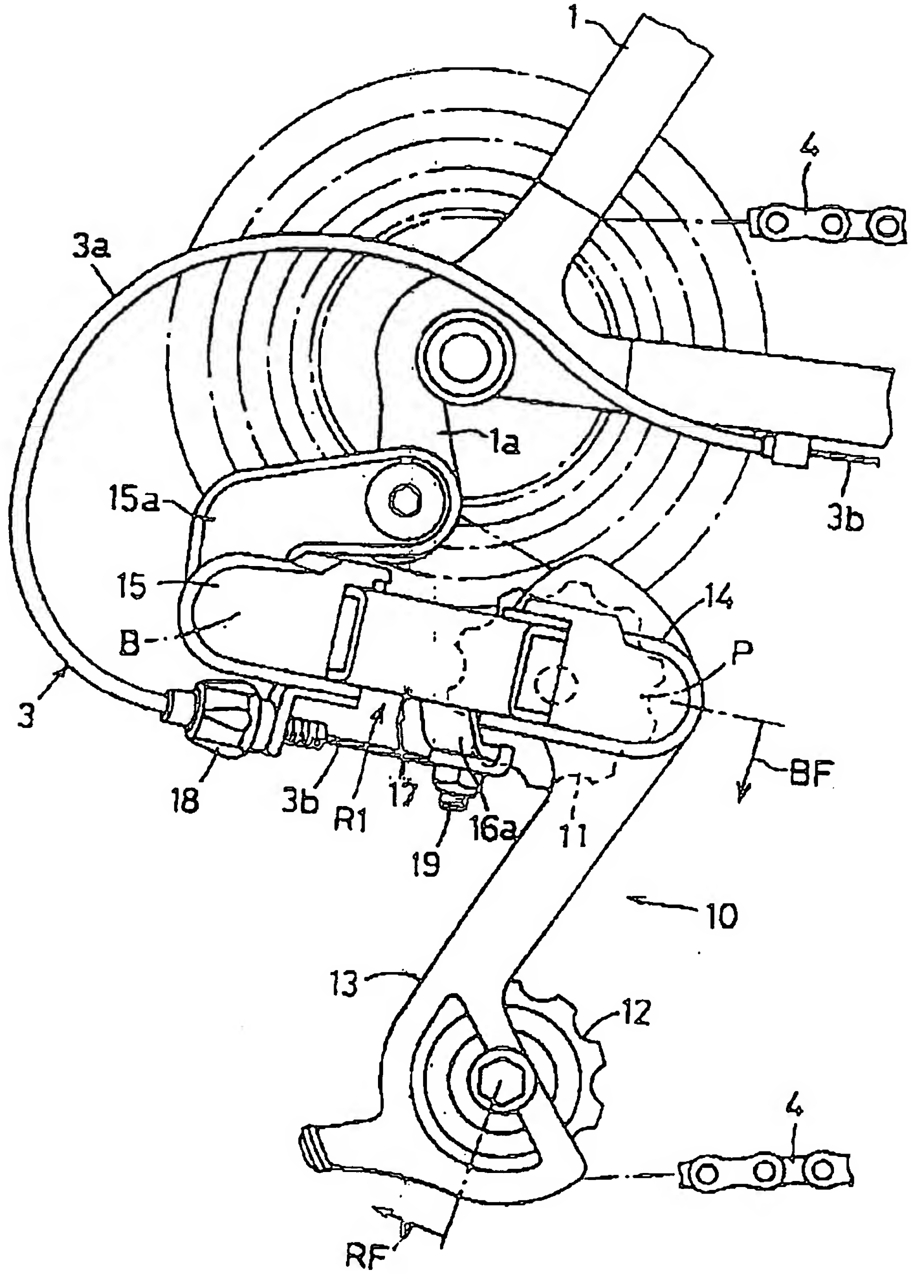
    a transmission (10) connected to a transmission cable (3) and having a return spring (RS) for exerting a first tension on the transmission cable (3);
    a shift control device (20, 40) coupled to the transmission cable (3) and having an assist spring (AS) for exerting a second tension on the transmission cable (3);
    wherein a difference between the first tension and the second tension remains substantially constant across substantially the entire operating range of the shifting device.

17. The device according to Claim 16 wherein the first tension and the second tension remain substantially constant across substantially the entire operating range of the shifting device.

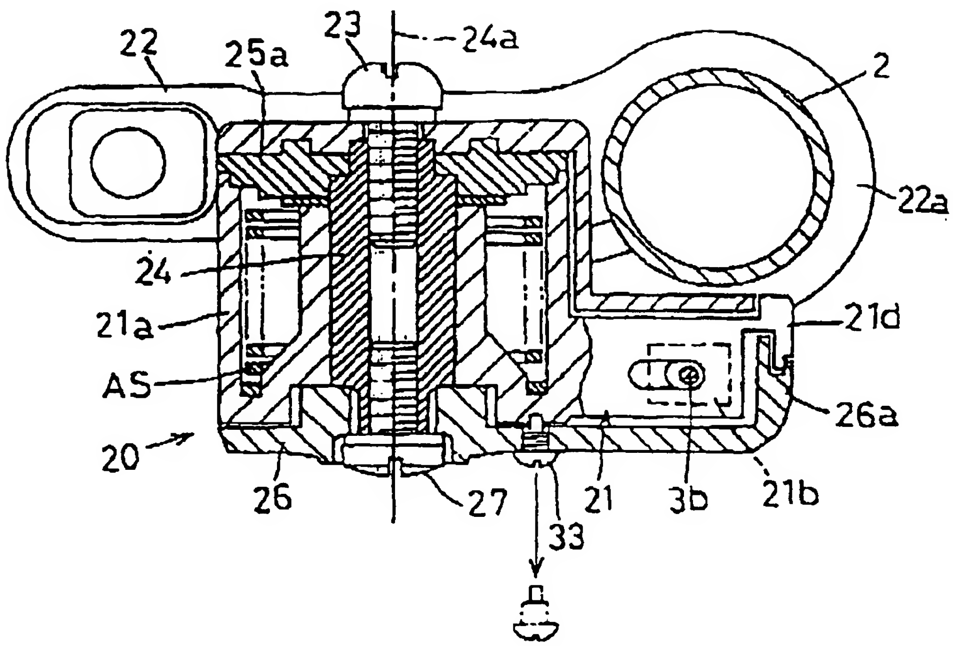
[Figure 2]


14
S2
P
X
R1
16
19
RS
17
10
11
13
16a
3b
18
3a
B
15
15a
S1
3
First speed
U
21
AS
21b
24
20
24a
3b
28
3a

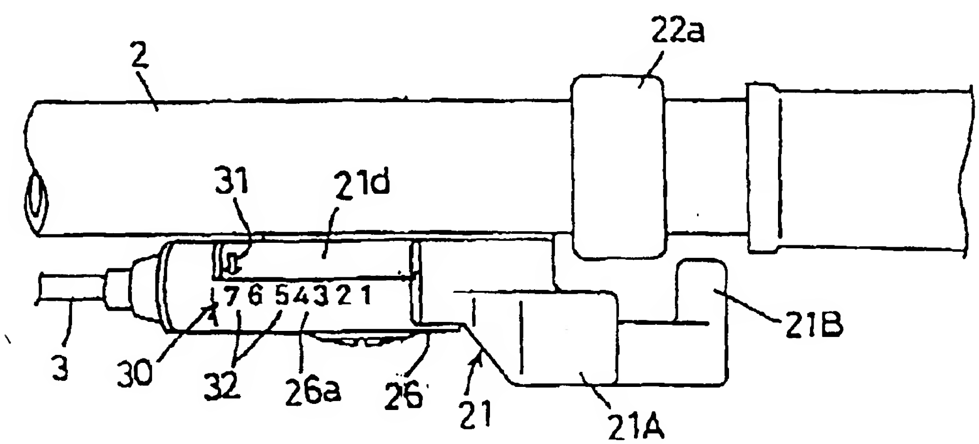
[Figure 3]



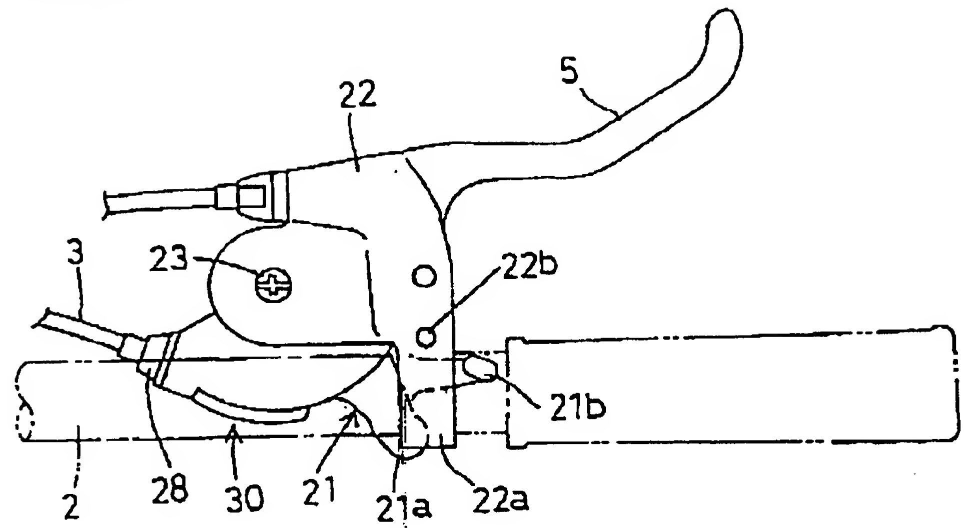
[Figure 6]



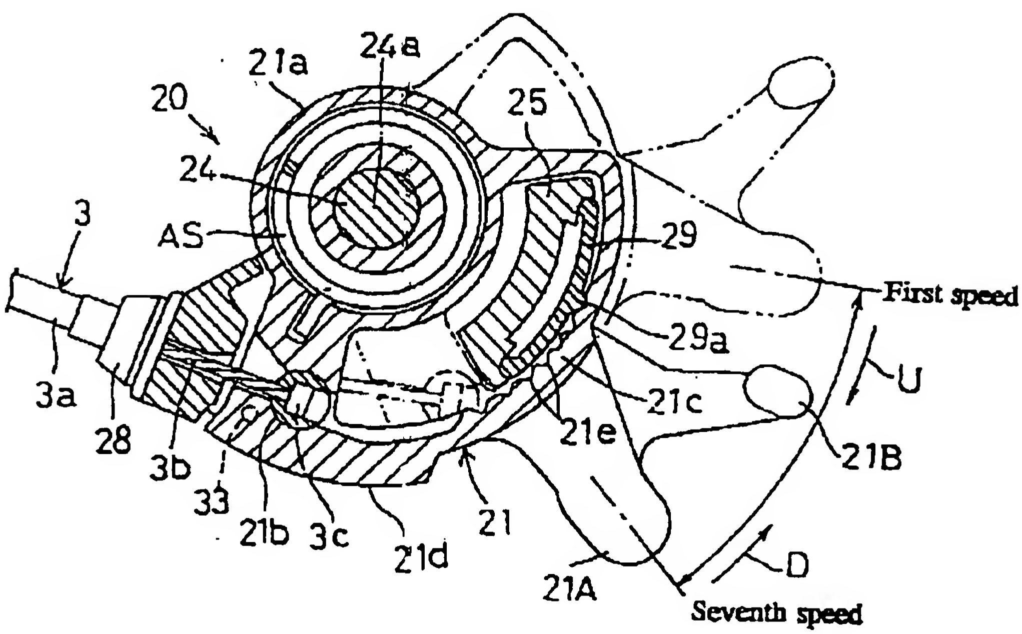
[Figure 7]



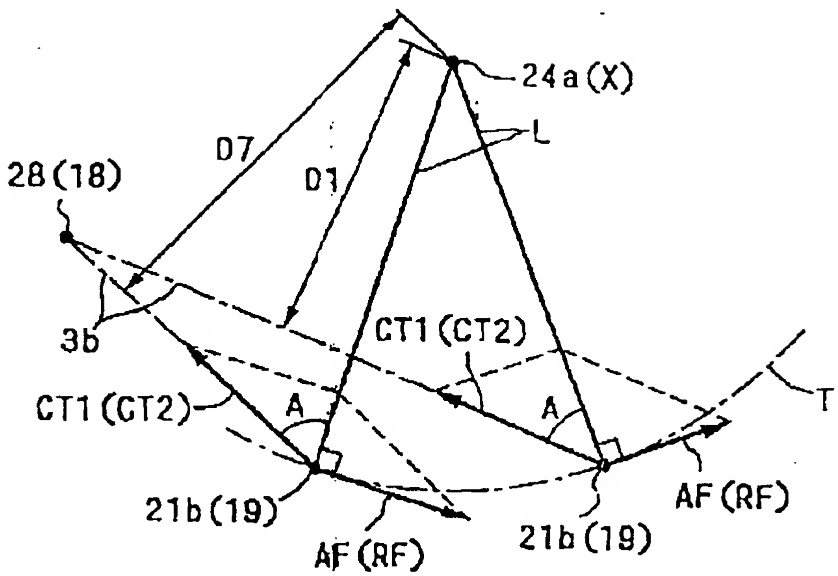
[Figure 4]



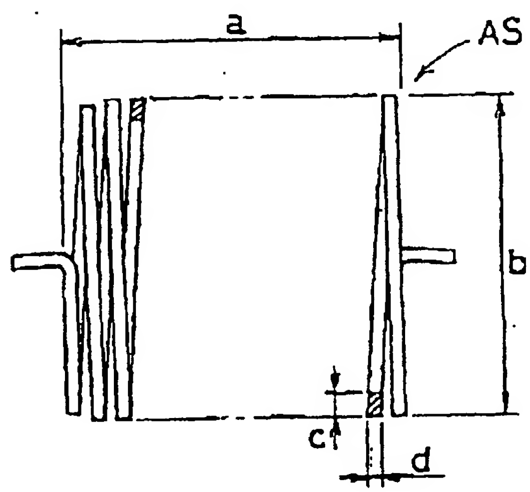
[Figure 5]



[Figure 8]

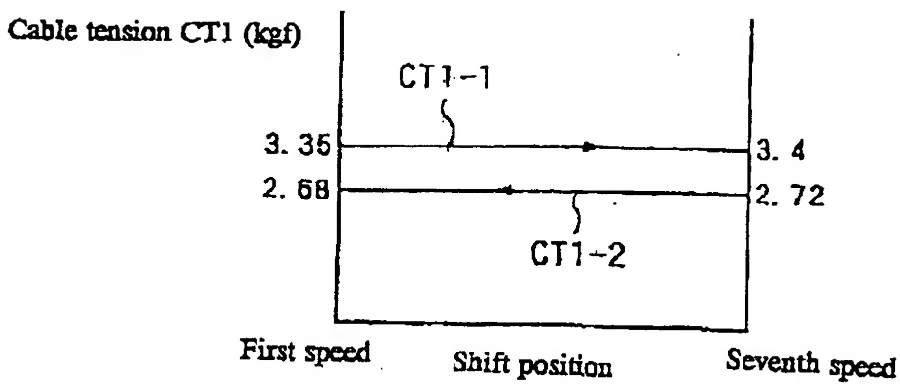


[Figure 9]

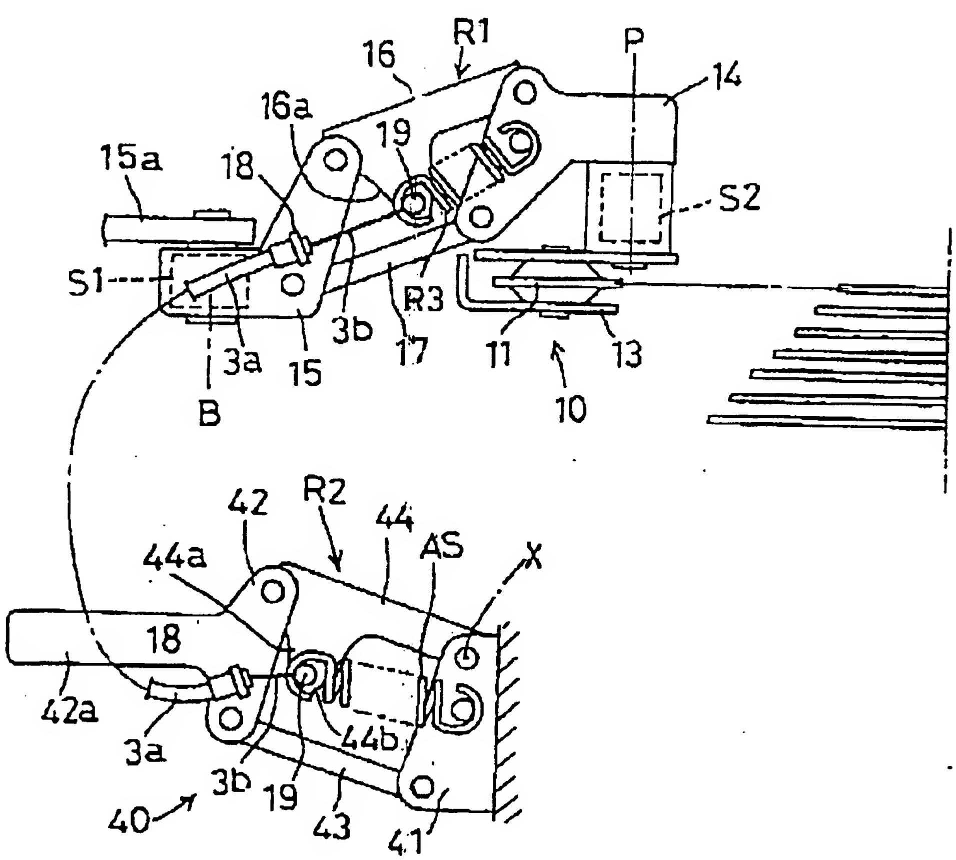


Dimensions of parts	a = 30±2, b = 29.2±0.3, c = 2, d = 1.2
Winding direction	Right
Total number of coils	11 coils, 180°±4°

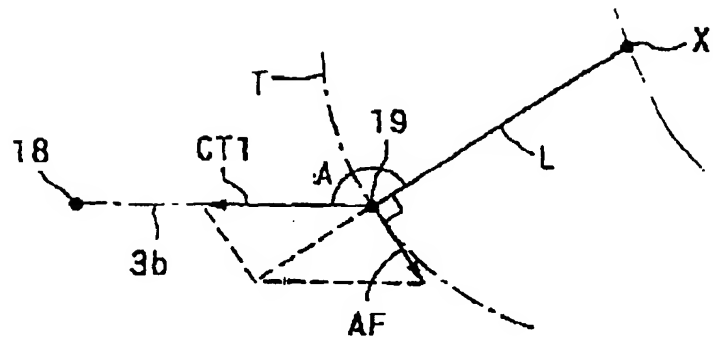
[Figure 10]



[Figure 11]



[Figure 12]



[Figure 13]

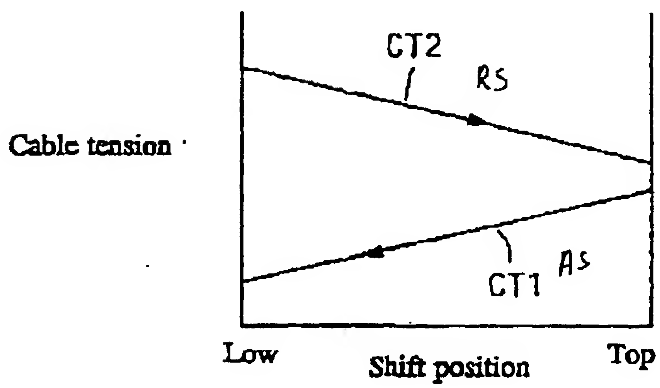
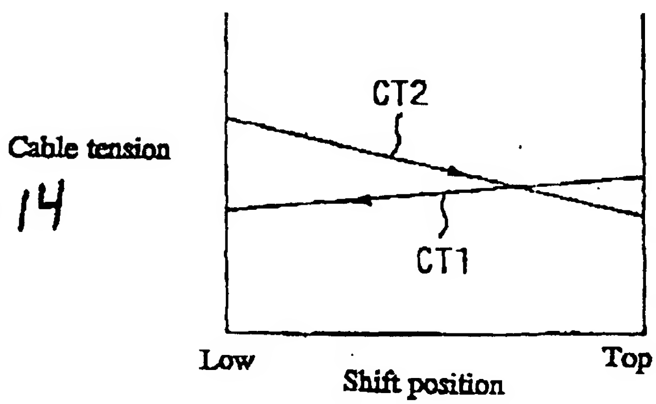


FIG. 14



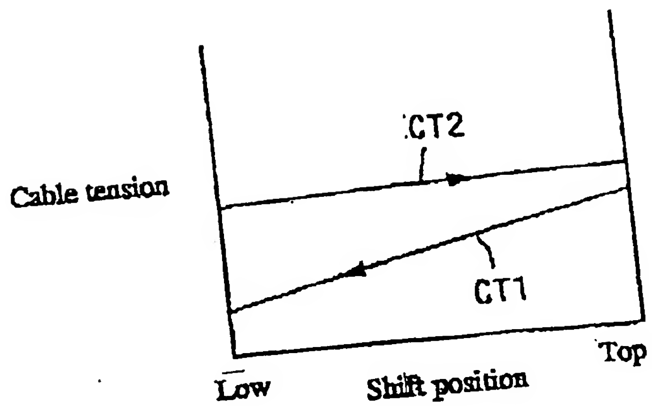


FIG. 15

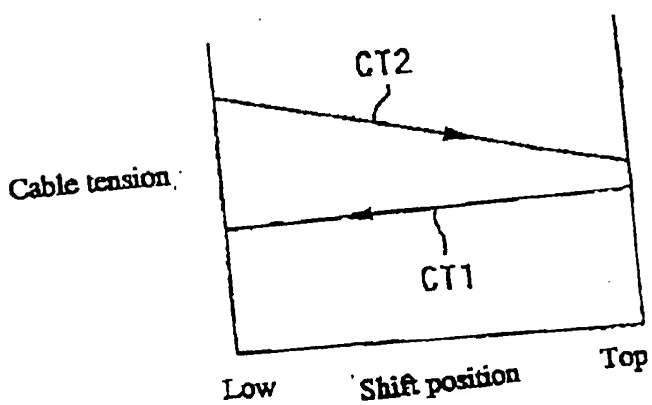


FIG. 16

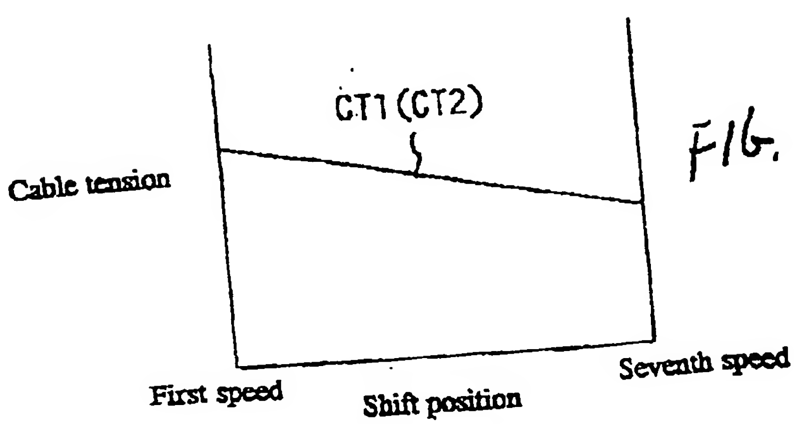


FIG. 17